

## An Experimental Study on the Effect of $\gamma$ -Irradiation on Concrete Strength

Hong-Pyo Lee<sup>a\*</sup>, Young-Chul Song<sup>a</sup>

<sup>a</sup>Korea Electric Power Research Institute, Environment & structure Lab., 103-16, Munji-Dong Yuseong, daejeon, korea

\*Corresponding author: hplee@kepri.re.kr

### 1. Introduction

P restressed Concrete Containment Building(PCCB) of nuclear power plant is important structures to prevent leakage of nuclear radiation such as gamma rays. PCCB has to play the role of shielding material which has to absorb the irradiation as well as the structural role. Gamma rays produce radiolysis of water in cement paste that can affect concrete's creep and shrinkage behavior to a limited extent and also result in evolution of gas. Prolonged exposure of concrete to irradiation can result in decreases in tensile and compressive strengths and modulus of elasticity[1]. Ref. 2 shows the test results for influence of  $\gamma$ -irradiation on concrete strength which was reduced about 10% at 50Mrad compared with normal condition type. In this point of view, this paper is mainly focused to describe the experimental results of concrete strength affected  $\gamma$ -irradiation.

### 2. Test Specimen

Thirty specimens which were classified into five groups according to the amount of the total absorbed dose were fabricated to use in the test. In the each group, three specimens were used in the uniaxial compression test and the other specimens were used in the split test. The size of concrete specimen is  $\Phi 100\text{mm} \times 200\text{mm}$ . The compressive design strength of the specimen is 40MPa. The mixture proportions of test specimen are provided in Table 1.

**Table 1. Concrete mixture proportions (unit:m<sup>3</sup>)**

Design Strength	40MPa
W/C(%)	45
W(lbs)	277
C(lbs)	493
Coares aggregate(lbs)	1,635
Fine aggregate(lbs)	1,274
F/A(lbs)	123
WRA(oz)	39.42
AEA(oz)	1.48

### 3. Method of Irradiation

The test of irradiation was carried out in the ARTI, where Co-60 is used as a gamma irradiation source. Photo 1 shows the view of experimental sight. The specimen were irradiated for 28days. The activity of source Co-60 and energy spectrum was 292kCi and 1.25MeV at average, respectively. The total absorbed doses of the test specimens, which were separated four groups were 50Mrad, 100Mrad, 200Mrad and 400Mrad, respectively. The condition of test was summarized in Table 2.



**Photo 1. Layout of the  $\gamma$ -irradiation test**

**Table 2. The irradiation condition**

	Total absorbed dose(Gy)	Absorbed dose rate(Gy/hr)
Group 1	0	0
Group 2	$5.0 \times 10^5$	$1.275 \times 10^4$
Group 3	$10.0 \times 10^5$	$1.099 \times 10^4$
Group 4	$20.0 \times 10^5$	$1.278 \times 10^4$
Group 5	$40.0 \times 10^5$	$1.177 \times 10^4$

### 4. Test Results

Compressive and split test for 24-specimen was carried out to measure ultimate compressive and tensile strength, the elasticity of modulus and poisson ratio of concrete using the UTM. Its maximum capacity is

200ton. The loading ratio for compressive and split test is  $(0.6 \pm 0.4) \text{MPa}$  and  $(0.06 \pm 0.04) \text{MPa}$  in accordance with KS F 2405, respectively. At first, the compressive strength test was applied to concrete specimen to measure ultimate strength of the specimen. After the test, modulus of elasticity and poisson ratio of concrete specimen were measured in the range of elastic behavior of concrete. Photo 2 shows the layout of the compression and split test.

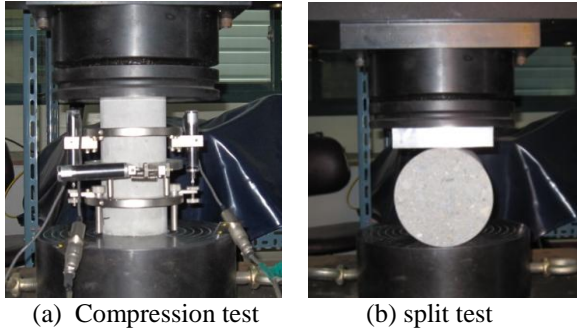


Photo 2. Layout of the Strength Test

From the compression test, strength for normal condition sample(Group 1) is 46.3MP which is more stiff than design strength. In case Group 2, the compression strength has increased to 6% compared with a normal condition specimen at average. These results differ with Ref. 2 whose result was decreased about 10% at 500kGy. On the whole, the compression strength of concrete was hardly exchanged due to amount of total absorbed irradiation. The split test results were also similar to compression test. Figure 1 and Figures 2 show the results for compression and split tests. Table 3 shows the results of the average strength of 5-Group.

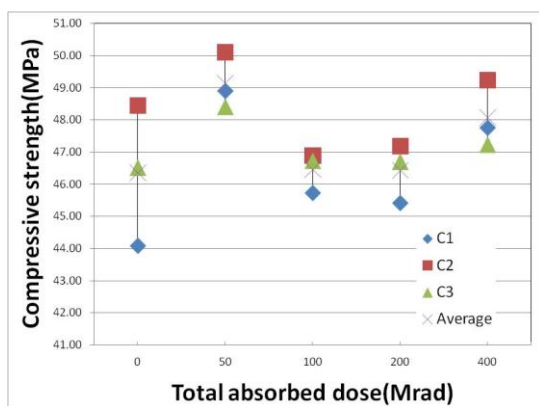


Figure 1. The results of compression test

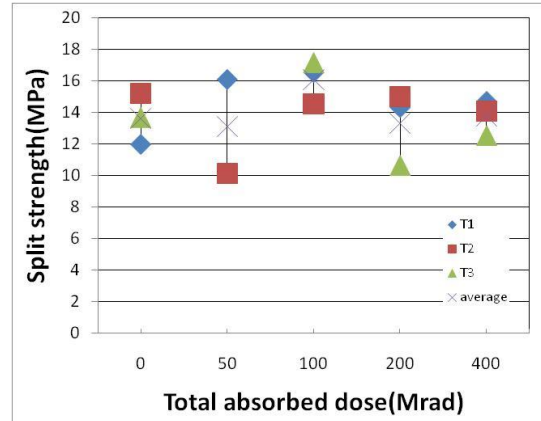


Figure 2. The result of split test

Table 3. The test result at average

	Compressive Strength (MPa)	Split Strength (MPa)
Group 1	46.3	13.6
Group 2	49.1	13.1
Group 3	46.5	16.1
Group 4	46.4	13.3
Group 5	48.1	13.8

## 5. Conclusion

This paper describes the experimental results on the effect of  $\gamma$ -irradiation for concrete structures in nuclear power plants. The tests were employed split test as well as compression test. The degree of the irradiation doses is from 50Mrad to 400Mrad. From the test results, the strength of concrete did hardly affect  $\gamma$ -irradiation during the service life.

## Acknowledgement

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## REFERENCES

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